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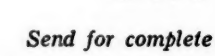

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THE JOURNAL OF PHILOSOPHY

THE MACROSCOPIC ATOMIC THEORY: A PHYSICAL INTERPRETATION OF THE THEORY OF RELATIVITY

THE physical and atomic view of nature which has dominated natural science for the last three centuries arose in Greece, when observers of the obvious extensive characteristics which nature presents to us were forced, by the presence of the two facts of stuff and change, to infer an atomic theory. In order to provide this theory with the adequate theory of motion which it requires, it was found to be necessary to posit absolute space.[1] This was the first complication which appeared in the doctrine. The absolute theory of space led naturally to a rigid separation of space and time and so necessitated the addition of another absolute called time. In the seventeenth century the astronomical and purely kinematic development from Copernicus through Tycho Brahe and Kepler combined, in the synthesis of Newton, with the physical and dynamic movement from Galilei through Huygens, to produce a third absolute called universal gravitation. The atomic presuppositions of this theory came out in the generalization of Newton's principles by Laplace; with the origin of modern chemistry in the work of Boyle, Lavoisier, and Dalton; and in the development of kinetic and statistical theories in thermodynamics and statistical mechanics. Thus, the atomic theory seemed to have brought everything within its domain. So certain of this fact were those mathematicians and physicists in good standing at the beginning of the nineteenth century, that when Young proposed evidence leading to a wave, rather than an emission, or atomic, theory of light, and Faraday said that there were lines of force which could not be reduced to the properties of atomic particles or electrified and magnetized bodies, they were ignored. Yet, finally fact won out over theory, but rather than admit that nature exhibits a relatedness which can not be reduced to the properties of the physical bodies that appear within the relatedness, another absolute thing-in-itself called the ether was introduced. Thus, at the beginning of this century, the physical and atomic theory which arose in Greece held the field, but only at the cost of complicating its doctrine to the extent of adding an absolute

[1] "The Theory of Relativity and the First Principles of Science," this JOURNAL, Vol. XXV, pp. 421–435.

space, an absolute time, absolute gravitation, and an absolute ether. It is to be noted that all these absolutes express those two facts in this universe before which the traditional atomic theory is weak: the fact of continuity, and the fact of relatedness. It is also interesting to note that the history of science for the last three centuries has been the story of a shift back and forth between a continuous and a discontinuous theory of nature. The Newtonian law, the chemical and kinetic atomic theory, Kelvin's and Maxwell's attempt to define matter in terms of the ether, the Lorentz and Thomson electron theory, the continuum of the theory of relativity, and the quantum theory follow each other in approximately the above order. This indicates that it is impossible to get an adequate theory of natural phenomena entirely in terms, either, of a continuum, or of the traditional discontinuous atomic theory.

Note what happened with the advent of the theory of relativity. With one stroke in 1905 Einstein removed the absolute ether, absolute space, and absolute time to substitute space-time, and with another stroke in 1914 he removed absolute gravitation and absolute space-time to substitute the variable space-time continuum of the general theory. The result was that the relatedness and continuity of the five separate absolutes were brought into one continuum or within one system of relations. This should make it evident that the traditional atomic theory is inadequate to provide a physical meaning for the theory of relativity. For, if the traditional atomic theory was insufficient to account for continuity and relatedness when it had each evidence of these two characteristics isolated, and could attack them independently, it can scarcely hope to do so when they have unified and consolidated their position.

The circumstances under which Einstein's revolutionary theory arose are important. It is to be noted that when Lorentz generalized Maxwell's electro-magnetic equations the result was an electron theory from which it followed as a deduction that the Michelson-Morley experiment should give a positive result. It is unnecessary to note how the modification in the equations of Lorentz necessitated by the negative results of this famous experiment produced a contradiction which could only be removed by accepting the special theory of relativity. The acceptance of the principle of the relativity of simultaneity, which is the essential point in the special theory, together with the principle of the absolute velocity of light, in vacuo, brought a union between space and time which was given mathematical expression in the Euclidean space-time geometry of Minkowski.

It is the path leading from this modified Euclidean geometry of the special theory to the Riemannian geometry of the general theory

which must be studied very carefully if the clue to the meaning of the theory of relativity is to be found. The consideration which led Einstein to make this additional advance was the principle, suggested by, but not fully realized in, the special theory, that the laws of nature should be independent in their formal properties of the frame of reference upon which one stands when one observes nature. Is it not possible, reasoned Einstein, to find an expression for the laws of mechanics which will apply to any body of reference whatever, regardless of whether it is moving with uniform rectilinear or accelerated motion? The next step was to ask whether mathematics can provide a law with the formal properties sufficient to meet such requirements. These requirements are that the form of the law must express something that remains constant when one shifts from one frame of reference to any other. It was evident that the tensor law of differential geometry meets these demands. But since there are as many difficult tensor laws as there are different geometries, the problem was to find the right one. Considerations from mathematics and physics joined to provide an answer to this question. On the mathematical side there is the fact that it is the g_{ik}'s which determine the metrical properties of space; on the physical side there is the fact of the equivalence of gravitational and inertial mass. This latter fact suggested that the extension of the principles of relativity to non-Galileian frames is possible, since it involved the thesis that phenomena, which from one frame of reference may be regarded as evidences of gravitational mass, may from another, with equal justification, be regarded as evidences of inertial mass. If that is the case, a connection between physics and geometry is established, because a body which to one frame of reference appears as inertial mass satisfies the principle of inertia and, hence, specifies that frame as a Galileian frame, whereas the same body which appears from a different frame as a gravitational mass does not satisfy the principle of inertia for that frame and hence specifies it as a non-Galileian frame. Now, a non-Galileian frame distinguishes itself in the world of mathematics from a Galileian frame by the fact that it involves Gaussian rather than Cartesian coordinates. Furthermore, Cartesian coordinates presuppose a Euclidean space, whereas Gaussian coordinates presuppose a non-Euclidean one. It is evident, therefore, that a law which is to remain invariant for non-Galileian as well as Galileian frames must have the formal properties of a tensor equation for non-Euclidean space. One may hasten to add, that when the law applies to Galileian frames, it must have the formal properties of a law for Euclidean space. This presents no difficulty however, so far as geometry is concerned. Although the non-Euclidean equation can never come out of the Euc-

lidean equation as a special case, the reverse is not true. Over very small regions and under certain restrictions it is mathematically possible for a Euclidean geometry or a Euclidean space-time geometry, such as the one involved in the special theory, to do so. This solves the problem of finding a law which will remain invariant for Galileian and non-Galileian frames, so far as mathematics or consistency is concerned.

It by no means follows, however, that this will solve the problem on the physical side. In fact, it will not do so unless one finds the particular Riemannian tensor equation in which the Riemannian space takes on Euclidean properties at every instance in which one steps from a non-Galileian into a Galileian frame. Now, what possible connection can there be between the passing of Riemannian geometry into the Euclidean special cases in pure mathematics and the jumping from accelerated railroad trains to the relatively stationary earth in the world of experimental physics? This question can be answered if we can find something in the world of physics that varies when we make these jumps (or when we pass from regions where Galileian coordinates apply to regions in which they do not apply), exactly as the g_{ik}'s of differential geometry vary when non-Euclidean space passes over into Euclidean space as a special limiting case.

It did not take Einstein long to discover what those factors were. In the first place, there is the fact that we feel no jerk or side pull when we are sitting at our desk or when we are moving in a train that is traveling with a uniform velocity on a straight track, whereas we do feel such forces when the train goes around a curve or slows down. This suggests that the thing in physics corresponding to the g_{ik}'s in mathematics which differentiates a Euclidean from a non-Euclidean frame is the presence of forces. Now, just as the curvature of space-time is specified when certain functions termed g_{ik}'s are given, so the characteristics of a field of force are specified when certain functions which the physicists term potentials are given. Furthermore, he noted that just as the potentials do not vary [2] when one is on a Galileian frame, so the g_{ik}'s do not vary in the Euclidean space-time that accompanies such a frame, and that, furthermore, just as the potentials do vary when one is on a non-Galileian frame, so the g_{ik}'s vary in the non-Euclidean space-time which accompanies such a frame. In addition he noted, when one considers gravitational as well as inertial forces, that in a body such as a freely falling elevator, the forces in its interior vanish (so as to permit one to regard it, as a frame at rest), only at a point, and that the g_{ik}'s in Riemannian or non-Euclidean space time, when it

[2] Providing one neglects gravitation.

becomes identical with the Euclidean special case, vanish only at a point. Thus Einstein perceived that there is a one-one correspondence between the potentials of the physicist as they distribute themselves in this actual physical universe with reference to non-Galileian and Galileian frames and the g_{ik}'s of the pure mathematician as one passes from the Riemannian to the semi-Euclidean space-time which is associated with these frames of reference. Thus he demonstrated that laws of mechanics for any frame of reference were not only mathematically possible, but also physically applicable to this concrete universe. This is his great achievement in the general theory. It was this discovery that the potentials which uniquely determine a field of force, and hence determine the motion of bodies, vary between different frames of reference exactly as do the g_{ik}'s in Riemannian space-time geometry when one passes from the non-Euclidean to the Euclidean limiting cases, which enabled him to say that a purely mathematical law taken from the pure mathematics of Riemann, when modified following the contributions of Minkowski to include space-time, should apply to the movement of physical bodies in this physical universe more exactly than the law of Newton.

It was this fact that potentials in physics correspond to g_{ik}'s in pure space-time geometry which enabled him to maintain, (when space-time geometry revealed only one Riemannian tensor law for a four-dimensional space-time which has a differential form of the second order [3] and this law requires the specification of ten g_{ik}'s), that an exact law of gravitation must require the specification of ten potentials and not merely the one potential of Newton's law. It was thus possible for him to argue from pure mathematics to experimental physics.

We are now able to understand precisely what the general theory of relativity asserts. It affirms that the relations between potentials in this physical universe have exactly the same formal properties as the relations between g_{ik}'s in the only possible Riemannian four-dimensional space-time geometry which is uniquely defined by a tensor equation of the second order.[3] Once this is known, the relation of implication holding between postulates and theorems in two systems with the same formal properties enables one to assert that every law which follows from this tensor law for geometry when g_{ik}'s are in the law, follows for this physical universe when potentials are substituted for the g_{ik}'s.

Once this is realized, it seems to be a mistake to set up a literal identification between the physics of the theory of relativity and space-time. Strictly speaking, if we limit ourselves to the minimum

[3] A law which will give rise to Newton's law as a first approximation must satisfy this requirement.

that is certain, the general theory of relativity refers only indirectly to space-time. What it asserts is merely that the relations which join potentials together in this concrete physical universe have the same formal properties as the relations which join g_{ik}'s together in a particular kind of space-time geometry. It is in the formal properties of the laws which describe them and not necessarily in their metaphysical essence that gravitational fields and space-time surfaces are identical.

It is a negative argument and not a demonstrated connection revealed by the general theory of relativity itself which has led to the identification of space-time and physical fields. The spatio-temporal characteristics of nature can not be referred to absolute space or absolute time since these absolutes no longer exist. Yet they must find some basis. The gravitational field suggests itself. But the theory gives no justification for a hasty identification, at least until we have analyzed the type of universe which the theory reveals and the conditions upon which it rests, to determine whether there may not be other more fundamental conditions for spatio-temporal appearances. This is especially true since the general theory says merely that the laws which join potentials together in gravitational fields have the same formal properties as the laws which join g_{ik}'s together in a certain Riemannian space-time geometry.

This comes no nearer to proving that our universe is a literal four-dimensional system, and hence beyond the reach of our imagination, than the fact that an adequate mathematical treatment of the behavior of the molecules in a three-dimensional glass sphere, which involves the recourse, because of the components of velocity, to a geometry of six dimensions,[4] proves that the system of molecules in question is a six-dimensional system which ordinary mortals can not perceive. Providing one draws a distinction between the formal properties of the laws, and the physical system to which those laws refer, there is no difficulty in reconciling a three-dimensional physical universe, which the imagination can grasp, with a law applying to that universe, the formal properties of which, when stated in literal geometrical terms, involve a space-time system of four or more dimensions. In other words, there is nothing in the general theory of relativity which thrusts the world of modern physics out beyond the reach of the senses or the imagination into a four-dimensional realm of pure reason where only pure mathematicians can grasp it.

The most important point to realize in thinking about this theory is that it is a theory about potentials and the relations which hold

[4] C. J. Keyser, *Mathematical Philosophy*, pp. 338–339.

between them. In other words, it is a physical theory. But we can not stop at this point. Potentials are not ultimate things-in-themselves. Like the systems of pure mathematics, they can not stand on their own feet. They are terms invented by physicists to express the effect which a field of force has upon a body that is in it. They uniquely describe the field in the sense that when they are specified all the significant effects which the field in question will produce on bodies are known. It follows, therefore, that the theory of relativity is a theory about a field of force, particularly, with reference to the effect which that field will have upon the motion of bodies.

In the general theory of Einstein the tensor law is a statement about the gravitational field only; the electro-magnetic field to which the ϕ_i's refer is not described by the same law. There are in his theory two continua which are not brought into relation with each other. In the generalized theory of Weyl this dualism is removed so that the relation between the g_{ik}'s or gravitational potentials and the relationship between the ϕ_i's or electromagnetic potentials is expressed as one relationship by a single tensor equation.

Two points may be noted with reference to the difference between the theories of Einstein and Weyl. The main motive, so far as his writings and the general physical emphasis in his thinking permits one to judge, which causes Einstein to reject Weyl's generalization is that it appears to involve a rejection of the possibility of regarding the relativity theory as a strictly physical theory. Space-time in Weyl's theory is not completely definable in terms of matter. Our analysis has justified Einstein's insistence upon the strictly physical implications of his theory. It is a theory about the potentials of the physicist and not about the space-time of the pure mathematician. But does this have the consequence for Weyl's theory that first suggests itself? May it not be the case that the necessity which Weyl finds [5] for rejecting Einstein's thorough-going physical interpretation arises from the inadequacy of the traditional atomic theory of matter? If this is so, it may be true, when we trace the general theory back to the physical consequences which it necessitates, that a new physical basis may be found for the mathematical relatedness which Weyl finds it necessary now to posit as an irreducible factor.

In the second place Einstein has objected to Weyl's thesis that the electro-magnetic as well as the gravitational field determines the structure of space-time. This goes back to a proposition which Einstein stated in his original paper on "The Foundation of the General Theory of Relativity" [6] in which he said: "Thus, according

[5] H. Weyl, *Raum, Zeit, Materie,* Funfte Umgearbeitete Auflage, Berlin, 1923, pp. 268–308. Also *Was ist Materie?* Berlin, 1924, pp. 60–88.

[6] *The Principle of Relativity,* A. Einstein and Others, Methuen, London, p. 120.

to the general theory of relativity, gravitation occupies an exceptional position with regard to other forces, particularly the electromagnetic forces, since the ten functions representing the gravitational field at the same time determine the metrical properties of the space measured." Einstein's reluctance to establish a literal identification between space and the electro-magnetic field seems to be justified, but, particularly, because it is a mistake at this stage of the analysis to establish a literal identification between space and any physical field, be it electro-magnetic or gravitational.

Stated in terms of the minimum which is certain, what Einstein's proof that gravitational fields affect space-time means is merely that the introduction of gravitational fields into a physical region produces a variation in potentials throughout the region which is exactly analogous to the variation in g_{ik}'s which takes place on the continuum of a space-time geometry when a non-Euclidean region appears within a Euclidean surface. That there are many arguments in favor of a more literal identification between physical fields and the spatio-temporal characteristics of nature can not be denied. Even enlightened common sense should now tell us that we are looking into an electro-magnetic and gravitational field and not into a void when we look out through so-called space into the heavens. Furthermore, it seems quite probable that gravitational fields determine the behavior of our measuring rods and hence should affect the physical geometry of our universe. The point is, however, that the theory itself does not necessitate such an immediate specification of the physical foundations of space-time and that it does not seem wise, therefore, to go on record upon this point until we have pushed the general theory through to its completely physical consequences to determine what the possible physical conditions for space-time may be.

This possibility must be taken seriously the moment we note that the field, be it gravitational or gravitatio-electro-magnetic to which the theory of relativity refers, has kinetic atomic as well as physical conditions. This follows, because in the general theory, space-time varies with the redistribution of matter. As we have indicated elsewhere, the fact of a field can only be reconciled with the fact of change in that field if the field is atomic in character. Thus, the fact of the variability of the field plus principle number four of our previous analysis [7] enables us to conclude that the field to which the tensor equation for gravitation refers is constituted of a tremendous number of smaller atomic fields which are in motion. This is precisely what the historical presuppositions of the theory

[7] "The Theory of Relativity and the First Principles of Science," Principle (4), p. 434, this JOURNAL, Vol. XXV, 16.

indicate. Lorentz's work rests upon an electron theory;[8] we know, in addition, that the molar bodies to which gravitational fields relate themselves are constituted in part at least of electrons and protons. We must not conclude, on this ground, that gravitation reduces completely to the properties of the electrons and protons in the compound molar bodies. Our knowledge of the relation between electrons and gravitation is not sufficient to permit such a conclusion. The fact of variability in the field to which the potentials refer is sufficient, however, to prove that the field must be atomic in character.

Since our procedure is to work back from the theory of relativity through its actual connections with nature, to the particular physical conditions which it presupposes and implies, all danger of begging the question will be avoided if the argument to the atomic theory rests solely upon the implications of the relativity theory itself. References to other developments in physics are significant as checks upon our deductions, but not as the sole justification for them.

It must be noted, furthermore, that the atomic theory[9] must be a different one from the theory of the Greeks. If a field running throughout the whole of nature is to be built up out of atomic parts, it follows that the parts must be fields with their central charges and not merely elements, like billiard balls, with abrupt boundaries. This, also, is in accord with the results of recent atomic theory in which the electron and proton is conceived to be, not merely a central charge, but a central charge plus its field. The variable character of the compound field, to which the tensor equation for gravitation refers, necessitates this theory of atomic fields; the recent investigations in quantum theory confirm the fact of the existence of the type of atomic entity which such a theory of atomic fields would involve.

It must be remembered that these atomic[9] fields are in motion. Otherwise the fact of variability and change in the continuum would not exist. We come again upon the problem of motion. This brings us to the discovery of an unexpected consequence of the theory of relativity. We have demonstrated that the theory implies a kinetic atomic universe. This follows because the theory refers to a physical field which contains real change.[10] The Greeks demonstrated

[8] *The Theory of Electrons*, H. A. Lorentz. Second English Edition, 1916, p. 8 ff.

[9] We are using the term "atom" in this paper in its philosophical sense as the ultimate indivisible entity and not in its chemical sense. When the latter meaning is involved the expression "chemical atom" will be used.

[10] "The Theory of Relativity and the First Principles of Science," Principle (4), page 434, this JOURNAL, Vol. XXV, 16.

that if this is a kinetic atomic universe then there must be something else in it other than the atoms, to provide a referent for their motion and a basis for the discontinuity which they involve.[11] The special theory of relativity demonstrated that this can not be absolute space. The theory of relativity necessitates, therefore, that an entirely new entity must be added to the modern physical theory to replace the absolute infinite space of the traditional theory. In other words, there is in this universe, in addition to the electrons and protons, an entity which the traditional analyses failed to discover. Einstein, when we grasp the full significance of his work, has demonstrated that the Greeks and Newton introduced the wrong metaphysical entity when they posited absolute space as the referent for atomic motion and the basis for discontinuity. We must conclude, therefore, as a necessary deduction from the theory of relativity, that there is an entity in this universe, in addition to the electrons and protons, and that this object has the properties sufficient to provide a referent for their motion and a field against which they may move.

Two properties, which the physical field of the general theory possesses, indicate precisely what and where this additional object is. The compound field described by the theory of relativity so distributes its potentials that a law of a variable Riemannian form is required to express the relations between them, and it exhibits over wide regions an unexpected amount of uniformity. It is the Riemannian character of the law which expresses the presence of gravitational forces; it is the approximate uniformity of the field which makes measurement possible without a knowledge, except in cases of most refined experiment, of the particular distribution of matter in the region measured. The only explanation of this latter fact, other than Whitehead's, which is unsatisfactory on certain other points,[12] is that, except for very slight variations, a certain uniformity over nature as a whole must be preserved regardless of how matter may distribute itself. It follows, therefore, that this additional object must be in that relation to the microscopic atomic fields and must possess those properties, which will enable it to impose a constant uniformity upon the resultant motion of the electrons and protons, and at the same time permit them to compound into molar bodies to produce gravitational fields and the local Riemannian distribution of potentials.

The steps leading to the discovery of this additional object come out very clearly if we begin with the compound field which the

[11] *Ibid.*, Principle (5), p. 434.

[12] It involves a rejection of Einstein's general theory. See *The Principle of Relativity*, by A. N. Whitehead, Cambridge, 1922, p. 58.

theory of relativity describes, and note those characteristics in it which the microscopic electrons and protons do not provide. The field, because of the variability which it involves, must be atomic in character. We are forced to think of it, therefore, as an equilibrium of the electrons and protons. The question immediately arises concerning whether the characteristics of this equilibrium or compound field find their basis solely in the motion and properties of the microscopic fields. The theory of relativity gives us information which tells us that they do not. This information appears in the approximately macroscopic uniformity which space-time must exhibit.[13] For it follows logically that if the microscopic fields have the properties required to provide the space-time variability, which is the essential point in the general theory of relativity, then they can not possess the properties sufficient to produce the general macroscopic uniformity which is also present. The reason is that a variable space-time which finds its basis in matter must be defined in terms of relations between microscopic atomic fields, the central changes of which stand in external[14] relations to each other. Only upon such a basis is it possible for the atomic fields to produce one type of relatedness at one stage of their motion and another type at a different stage. Since the theory of relativity requires such variable relatedness, it follows that the uniform structure which it also requires can not find its basis in the microscopic atoms. It follows, therefore, that there is another pole to the equilibrium other than the one provided by the microscopic fields, and that this pole stands over against the microscopic parts to impose upon the product of their compounding, an approximately uniform relatedness which they alone are incapable of introducing. Furthermore, this other pole must have two properties. It must be uniform and large enough so that its effect will be to integrate and organize and, as we have also noted, to congest the electrons and protons; and it must be physical. This last qualification is essential. For, if this other pole of the equilibrium is capable of forcing the microscopic atomic fields to produce an equilibrium with a uniformity which they alone would not introduce, it must be capable of changing the direction of their motion. Since this calls for an external physical force, it follows that before such a task a purely logical mathematical relation

[13] Only upon this assumption does Einstein's law for gravitation give rise to Newton's as a first approximation. Cosmological considerations necessitate the same conclusion. See *Principle of Relativity*, A. Einstein and Others, London, 1923, pp. 158, 159, and 184. Also see the arguments by A. N. Whitehead which indicate that without some uniformity physics is impossible. *The Concept of Nature*, Cambridge, 1920; *The Principle of Relativity*, Cambridge, 1922.

[14] In the logical sense.

or a general philosophical principle would be helpless; only a physical object external to and surrounding the microscopic atomic fields of the entire universe will suffice. It follows that the object with the minimum properties sufficient to meet these requirements is a macroscopic physical atom, spherical in shape, hollow in the center except for its inner field,[15] and large enough to contain and congest in its interior all the electrons and protons which constitute nature.

The inductive argument to the existence of the macroscopic atomic theory may now be summarized. An analysis of Einstein's general theory reveals that it is a theory about potentials and, hence, about a physical field; that this physical field varies and hence must be constituted of atomic parts; and that it exhibits a macroscopic uniformity, and requires a referent for atomic motion in something other than the microscopic atoms, which can only be supplied by the macroscopic atom. Unless the macroscopic atom is admitted the physical theory of nature fails because of an inadequate theory of motion and because of its inability to account for the peculiar combination of spatio-temporal variability and uniformity which exists. It may be said, therefore, that the theory of relativity implies the existence of the macroscopic atomic theory.

The necessity of this new physical theory being demonstrated by an analysis of the theory of relativity and its implications and presuppositions, it remains for a deductive treatment to indicate its sufficiency. We will proceed now from the macroscopic atomic theory to the theory of relativity.

The macroscopic atomic theory provides us with the following entities: all the microscopic atoms (electrons and protons) of the traditional physical theory and the macroscopic sphere which surrounds and congests them. The atoms, both the many microscopic and the one macroscopic, possess fields. The microscopic atoms are in motion. The source of their motion is internal. The presence of the macroscopic atom, surrounding the microscopic atoms, provides a genuine referent, in the shell and its field, for the motion and discontinuity of the microscopic particles. Thus the physical theory is able to stand before the analyses of Parmenides and Whitehead, notwithstanding the rejection of absolute space which came with Einstein's special theory. It is to be noted, also, that the macroscopic atom is an improvement over the traditional absolute space. Since

[15] It is necessary if action at a distance is to be avoided, and most natural, in the light of our knowledge of the microscopic atoms, to suppose that this macroscopic atom is not merely a hollow physical sphere, but also an inner field, which exhibits a passage from higher to lower potential as one proceeds along any radius from the outer shell to the center. Thus, just as an electron is its central charge plus a field extending out from that charge, so the macroscopic atom is the physical shell plus its inner field.

the metrical properties of space are never prescribed by space itself, Euclidean space can not stand upon its own feet, and hence should never have been taken as ultimate. Furthermore, the coupling of absolute space with a physical theory involved a fallacious muddling of physical and logical or mathematical categories. Only in the macroscopic atomic theory is the physical theory carried through to its logical consequences.

The macroscopic atom must be smaller than the region which the microscopic particles would occupy were it not present. Otherwise it would have no congesting effect upon the microscopic particles and the compound field with its general macroscopic uniformity would not exist. This congesting tendency of the macroscopic atom forces the microscopic atomic fields to press against each other to produce a partial equilibrium. Thus order between molar bodies as well as within them finds its basis in something more fundamental than the accidents of chance combination, important as these are. The behavior of any compound field or body in nature is determined not merely by the microscopic atoms which it contains, but also by their relation to each other and to all other systems and atoms in nature. Thus the macroscopic atom brings the structure of the whole to bear upon every part. The molar level of nature upon which we live is, consequently, a union or equilibrium of the microscopically small and the macroscopically large.

The consequences of the macroscopic atomic theory with reference to spatio-temporal order are of special interest. It is to be noted that the macroscopic atom is a three-dimensional Euclidean sphere. It is to be noted, also, that the motion of the microscopic atoms has the consequence of making the relations between physical objects an effect and not a cause. It follows, therefore, that space and time, which are relations, must find their basis in terms of the properties of matter. Space is the relationship which would result were the microscopic atoms stopped at a given stage of their motion, and connected by lines. The set of imaginary lines produced would be what we mean by space. Time is a difference between permutations, or between several such systems of lines. Since the atoms are never at rest it follows, therefore, that there is no such thing in this universe as an ultimate absolute space.

In fact, it follows as a deduction from the macroscopic atomic theory that space-time must be ultimate. For the atoms because of their motion are producing a given permutation or space, and a difference of permutation or time in one single act. Thus, the kinetic character of the macroscopic atomic theory insures that the ultimate fact must be space-time. Space-time is not built up out of absolute space and absolute time; instead, the latter are abstrac-

tions from space-time. Since in local regions the amount and distribution of matter is varying, it follows that space-time must vary, as the general theory of Einstein prescribes.

It is to be noted, moreover, that space-time has its *ultimate* basis, not in the field of potentials to which Einstein's tensor equation for gravitation refers, but in the motion of the microscopic atomic fields which condition that field. This point is very important, since it enables us to provide the universe of the theory of relativity with the psychological simplicity that it has previously lacked. The macroscopic atom is a three-dimensional Euclidean atom. Since this atom embraces the whole of nature, the universe can possess but three dimensions, therefore. The fourth dimension, so-called, in the mathematics of Einstein's theory, owes its existence solely to the change in relational structure which the motion of the microscopic atoms introduces. Were the microscopic atoms at rest, the laws of nature could be expressed in terms of a three-dimensional geometry. In other words, the fourth temporal dimension is a mere abstraction from the motion of the microscopic atoms of a three-dimensional Euclidean physical system. Thus, out of a three-dimensional physical system which can be easily grasped by the imagination, a space-time geometry of four dimensions follows of necessity, due to the basic kinetic character of the macroscopic atomic theory. Hence, the universe of the theory of relativity is simple in the psychological as well as the logical sense.

The congesting influence of the macroscopic atom causes the fields of the microscopic atoms to combine with it own inner field to produce the compound gravitational and electro-magnetic field, in which we and all molar objects are imbedded, and to which the tensor equation of Einstein's general theory directly refers. This compound field may be called the ether. The result of this compounding, (according to laws which are not yet completely understood), is the production of molar bodies and the difference of potential in the surrounding region which they introduce. It is to these potentials that Einstein's theory refers. It is to be noted, therefore, that the theory of relativity applies immediately only upon the molar level; it does not immediately touch the atomic level of ultimate particles in which space-time has its ultimate basis, although as we have indicated, it presupposes this atomic level in the information which it gives us concerning the molar level. This explains how it is possible for this to be a three-dimensional Euclidean kinetic physical universe, notwithstanding the fact that the mathematics of the theory of relativity is four-dimensional and Riemannian. The motion of atoms on the atomic level introduces into our mathematics the fourth temporal dimension. Furthermore,

since we make our observations only on the molar level and do not see the macroscopic atom or the microscopic fields which exist on the atomic level, the particular way in which we separate the temporal and spacial aspects of space-time must be a function of the molar bodies to which we refer our observations. Since there is no basis on the molar level for giving one molar body priority over any other so far as rest is concerned, the principle of relativity holds in actual practice for all frames of reference upon the molar level where our observations must of necessity be carried on. Thus the application of the principle of relativity for Galileian and non-Galileian frames is consistent with the macroscopic atomic theory.

Furthermore, the motion of the microscopic atoms insures that the molar bodies and their accompanying regions of non-constant potential must also move. Since a variation in potential distribution can only be expressed mathematically, in a form invariant for any reference frame, by a law which has the formal properties of a law for a Riemannian type of geometry, it follows that the three-dimensional universe of the macroscopic atomic theory must of necessity give rise to the type of field upon the molar level which can only be described mathematically in terms of a space-time continuum which is four-dimensional and Riemannian. Thus the four-dimensional Riemannian form of the tensor equation of gravitation of Einstein's general theory follows as a necessary consequence of the macroscopic atomic theory.

It is to be noted that spatio-temporal variability has an atomic as well as a molar basis in the nature of things. Its origin on the molar level has been explained above. Its existence on the atomic level follows of necessity from the definition of space-time which the macroscopic theory provides; and what is even more noteworthy, it follows at precisely those places in nature where experiment has revealed variability in spatial relatedness to exist. Consider, again, what one means by the structure of space, upon the basis of the macroscopic atomic theory. Space is the system of lines which would exist if we stopped all the microscopic atoms in their motion and connected them. Several such stoppages would produce several different spaces. If there is to be any such thing as an absolute or uniform space it follows that some relationship existing between the microscopic atoms must remain constant through all their motion. The motion of the microscopic particles and the distribution of matter from region to region in nature to which this motion gives rise necessitates that in any specific local region the relationship between the atomic particles must vary. Thus when we view nature microscopically over local regions it follows that spatio-temporal variability must be the rule. This is what Einstein's

theory reveals and precisely where it reveals it. In a local region no possible choice of coordinates will cause the g_{ik}'s to take on those constant values, 1, —1, 0, which are necessary if space-time is uniform. Spatio-temporal variability is possible upon the basis of the macroscopic atomic theory because relatedness is always an effect and never a cause. Hence it can exhibit one form at one stage of microscopic atomic motion and a different one at another.

This, however, is but one aspect of the picture. We have considered spatio-temporal structure purely from the point of view of the effect of the changing distribution and relationship of the microscopic atoms. There is also the macroscopic atom. Its effect is precisely the opposite of that of the motion of the microscopic particles. Whereas they tend to produce spatio-temporal variability, the macroscopic sphere, because of its fixed form and congesting influence, tends to produce spatio-temporal uniformity. It insures for the universe, when considered as a whole and viewed macroscopically, that regardless of local microscopic variations due to the motion and redistribution of the microscopic particles, the general relationship existing between all the atomic entities must remain practically constant forever. Thus, it follows of logical necessity from the macroscopic atomic theory that spatio-temporal relatedness should exhibit the peculiar combination of macroscopic uniformity and microscopic variability which measuring and the theory of relativity reveal and presuppose. Thus for the first time we have an explanation of why the theory of absolute space has worked in a universe in which space is a function of the motion and properties of physical objects. As Whitehead has indicated,[16] one would

[16] A. N. Whitehead, *The Principle of Relativity*, p. 59.

expect, if space depended solely on matter, that astronomical distances could not be measured without a determination of the distribution of matter in the region to be measured. This, however, we know to be unnecessary except for velocities which are exceptionally large compared to the velocity of light. The reason why this is so, notwithstanding the complete dependence of space upon matter, is because the macroscopic atom causes the local variations arising from the motion of microscopic and molar bodies to cancel themselves out over wide regions, so that the spatial relatedness of nature remains practically constant during the motion of matter. It is a unique merit and overwhelming argument in favor of the macroscopic atomic theory of nature that it provides the microscopic spatio-temporal variability which is the essential point in Einstein's general theory, and at the same time gives rise to the macroscopic uniformity which nature also exhibits.

Einstein, in insisting that his theory was a physical theory with-

out introducing this amendment to the traditional physical atomic theory, attained an adequate theory of spatio-temporal variability at the cost of a false theory of motion and an inadequately grounded theory of uniformity; Whitehead, by making space-time independent of matter, attained an adequate theory of uniformity and motion at the cost of the denial of Einstein's general theory and the spatio-temporal variability which the experimental evidence for it revealed. Only in the macroscopic atomic theory does the peculiar combination of microscopic variability and macroscopic uniformity find a basis.

It is a striking argument in proof of the existence of the macroscopic atom that this object which (now that Einstein's special theory has removed absolute space) is necessary as a referent for atomic motion, and which is partially responsible also, due to its congesting influence, for the origin of molar bodies and spacio-temporal variability, is also responsible for spacio-temporal uniformity. An object, which replaces the four absolutes—space, time, universal gravitation, and the ether,—to meet so many difficulties, and which gives rise to a peculiar combination of apparently contradictory manifestations which one would not expect to have any ultimate connection with each other, can scarcely be regarded as an *ad hoc* addition to our scientific knowledge. It meets too many difficulties and replaces too many absolutes to be regarded in any such light. Upon the basis of this theory the complexities of nature are frankly faced and find their foundation in a physical theory which is simple and which brings relativity physics into clear relationship with the other atomic developments in physical and biological science; upon any other basis the universe tends to become regarded as a four-dimensional Reimannian surface with a peculiar returning curvature which places it beyond the reach of our imagination and disconnects it from atomic physics and the modern scientific tradition in a way that makes us feel that we are dealing with convenient tools for description and prediction, but not with the concrete nature of things.

This theory also resolves the paradox concerning how space-time can determine the motion of matter and at the same time be completely conditioned by matter. This paradox arises from the impossibility, if the macroscopic atom is not known, of distinguishing between matter in the sense of the electrons and protons alone, and matter in the sense of electrons and protons, plus the macroscopic sphere. Matter in the latter sense completely conditions the gravitatio-electro-magnetic field or molar space-time; matter in the former sense is partially conditioned by the field since there is an element of structure in the field which the microscopic constituents of local bodies do not completely prescribe.

In this distinction the fundamental enigma of modern science finds its resolution. How can nature be atomic as Greek natural philosophy and three centuries of technical investigation by modern science have revealed and yet involve a structure in the chemical atom, an organization in the living organism, and a spatio-temporal relatedness in the universe as a whole which is indefinable, completely, in terms of the properties of electrons and protons? How can the traditional atomic theory be true and yet inadequate? Why, if nature is atomic, has it been necessary during the last three centuries to introduce a continuous theory of nature from time to time in order to do justice to certain facts? To all these questions, at least, a partial answer is evident. The chemical atom of quantum theory, the living organism of biological theory,[17] the solar system of astronomical theory, and the space-time universe of relativity theory exhibit a relatedness which does not reduce solely to the properties of its microscopic constituents because each is a partial equilibrium between the microscopic elements and the perfectly geometrical spherical form and inner region of the macroscopic atom.

For the first time in the history of western civilization the macroscopic atomic theory makes it possible for one to hold to a physico-chemical and realistic kinetic atomic theory of natural phenomena and at the same time to do justice to the fact of order and organization in nature and its parts. No longer is it necessary to choose between Aristotelianism, with its teleology and its denial of the primacy of physico-chemical categories, and the traditional atomic theory, with its denial of any ultimate basis for order in nature. In the macroscopic atom which insures that every local system has a partial basis for its stability and structure in its relations to other systems and to the whole, the kinetic atomic theory finds a fertile source of explanation for the oneness, relatedness, and order of nature as well as for the atomic and physico-chemical character of its parts. In the enclosing spherical properties of the macroscopic atom which stands in an external[18] relation to the microscopic particles, the kinetic atomic theory also provides a fertile account of the baffling combination of internal and external relatedness which the field of nature that is before us for observation exhibits. The whole can not be completely known in terms of the part and yet there is an element of the whole in every local system. Again we see how the macro-

[17] The macroscopic atomic theory was discovered in 1922 in connection with an analysis of the problem of organization in biology. Its application to the living organism is not mere conjecture, therefore. Moreover, the argument to the theory from biological evidence is entirely independent of the argument given here.

[18] In the logical as well as the physical sense.

scopic atom gives us relatedness without giving us too much relatedness.

The question concerning the philosophical foundations of modern science also becomes resolved in terms of the physical theory of nature which the Greek atomic philosophers discovered, and which Galilei, Newton, and Dalton introduced into the modern tradition. The revelation of the weakness in the traditional physical theory which came with the discovery of the theory of relativity and with Weyl's, Eddington's, and Whitehead's objections to Einstein's attempt to give that theory a strictly physical interpretation has the final effect, not of necessitating the shifting of the structure of scientific theory to entirely new foundations of an Aristotelian or Platonic type, but of leading to the discovery of an additional physical object in nature which takes the physical philosophy through to its logical consequences. There is no need for a rejection of the physical theory of nature; it needs, merely, to be modified to meet new evidence.

The introduction of the four absolutes—space, time, gravitation, and the ether—was a mistake. They were the result of a fallacious procedure which muddled physical and mathematical categories and turned relations into non-physical metaphysical entities. Hence, Einstein, when he removed these excrescences and made possible the discovery of the incompleteness of the traditional physical theory, prepared the way for a complete development of its doctrine and a consistent rendering of its principles.

It would be to ask more of the Greek pioneers who discovered the physical atomic theory than the information which they had, would permit, to assert that they should have posited a physical object instead of the mathematical system of relations called Euclidean absolute space to account for atomic motion. Nevertheless, such is the only means of carrying the physical theory through to its logical consequences, and of developing a theory of natural phenomena which will fit the facts.

In any event this is the lesson which the centuries of scientific investigation since Leukippos and Democritus have to teach us. We must amend their famous saying to read: "All is atoms in motion and the macroscopic sphere." Only upon such a basis can this be a universe in which stuff and change and a peculiar spatio-temporal relatedness exist side by side.

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BOOK REVIEWS

Science and Philosophy and Other Essays. BERNARD BOSANQUET. New York: The Macmillan Co. 1927. Pp. 446.

The editors, J. H. Muirhead and R. C. Bosanquet, have gathered in a single volume twenty-four papers that were published chiefly in journals and in the books *Essays and Addresses* and *Aspects of the Social Problem.* The title of the collection is taken from the first essay, and the editors defend it on the ground that Bosanquet believed that ethics, politics, esthetics, and religion can not be ruled out of the field of science in the wider sense.

Three parts contain papers on logic and metaphysics, ethics, sociology and politics, and esthetics, published over a period of thirty-two years. They are arranged not in chronological order, but in skillful logical sequence. The result is that although papers published as widely apart as in 1889 and in 1915 are twice adjacent, the total impression with a few exceptions is that of chapters in a book. Such an arrangement of material illustrating Bosanquet's principal teachings testifies to the unity of his thought. Moreover, it affords a general reader the opportunity to become acquainted with the views of a great thinker through writings that are frequently simpler in language than his more important works.

In contrast with the wider view of science referred to by the editors, Bosanquet in the first essay uses "science" in the narrower sense of theoretical science. He points out that while science consists of abstractions, philosophy makes categorical judgments which are tenable in view of their being sustained by the whole body of propositions which can be affirmed of the real as such. Thus if logic is fundamental to philosophy, the object-matter of logic must be extended to include the consideration of beauty and goodness as well as the theory of the sciences.

The program for philosophy outlined in the first essay is exemplified in the following papers. In the second paper, Bosanquet states his fundamental principle of identity in difference, and in the immediately succeeding papers he tells how knowledge may supplant opinion when contradictions have been removed. Negativity, however, does not disappear when contradiction is removed, but remains as a real characteristic of the Absolute. In appropriate sequence the next papers defend the adjectival character of finite individuality and the presence of time in the Absolute. The section concludes with "The Permanent Meaning of the Argument from Design," in which the author seeks to show the relation of the causal forces of nature to the moral purposes of mankind apart from the theory of an external Divine Intelligence.

"The Practical Value of Moral Philosophy" serves to introduce the papers of the second section. Theory is not mere instrument in relation to practise, but the two are united in a direct effort after harmony of experience. "Recent Criticism of Green's Ethics" opposes A. E. Taylor's view that metaphysics is of no service to ethics because ethics contains the radical contradiction between egoism and altruism. Bosanquet believes that the difficulty in the contradiction is removed in view of the general principle that both the act which satisfies a private interest and the act which seems to diminish such interest are alike acts which promote the unity of the finite self with the Eternal Self. Again, hedonism is an insufficient moral criterion because it attends to the more obvious characters of facile satisfaction, whereas the principle of perfection steadily urges us toward a fuller life in which the arduous satisfactions play a large part. The idea of perfection as a moral criterion is not the abstract statement of the Absolute, but rather perfection working in a limited way in the dialectic of our desires, true for our life, though necessarily "tinged with falsehood" in view of complete achievement. How far does identity in the dialectic of desires enable us to predict human conduct? In a paper attacking Bergson's interpretation of scientific causation as bare identity, Bosanquet answers that the possibility of prediction is least in trivial cases of conduct, greatest in cases where a whole personality is involved. It is possible, he says, to predict conduct when one mind actually shares the conduct of another mind.

"The Prediction of Human Conduct" links the papers on ethical philosophy with those on sociology and political philosophy. "The Relation of Sociology to Philosophy" and "Social Automatism and the Imitation Theory," dealing with social philosophy of the late nineteenth century, are of historical rather than present interest, but in "The Reality of the General Will," reprinted from *Aspects of the Social Problem,* we find a clear statement of Bosanquet's theory of the general will, which gives his answer to the question of how one mind can share the content of another mind. The practical consequences of holding that perfection is the moral criterion are illustrated in "The Duties of Citizenship" and " 'Ladies and Gentlemen!' " In the latter paper Bosanquet finds the qualities connoted by "ladies and gentlemen" precious because they draw attention to the need of being able to express intelligence and goodwill in the detailed behavior of body and mind.

The four remaining papers of this section are more loosely adjoined. One of the most interesting is "The Idea of Decadence," in which, after naming particular features of decadence, as epigram, love of nature, love-romance, ethics of duty, sense of humanity,

and value of freedom, he says that its characteristic note is "the meaning of a great past being forgotten, but its tradition respected, and worked out by fragmentary applications which end in new forms, and which produce material for another age of supreme insight and creation" (pp. 317–318). The oft quoted essays, "On the True Conception of Another World" and "The Kingdom of God on Earth," interpret the moral and religious aspects of Bosanquet's view of the distinction between knowledge and opinion. There are not two worlds, but one world. The transformation of our lives into a more adequate expression of reality comes through scrupulous attention to "my station and its duties" and through the realization that we may find God in our own human nature because the material world and individual minds are expressions of His reality. The section ends with "The Place of Leisure in Life," a plea that everyone be given opportunity to occupy oneself in part with disinterested interests.

Of the three papers on esthetics in the last section, one outlines Bosanquet's interpretation of esthetic emotion as expression; another contains an appreciative, but keenly critical, discussion of Croce's view. Most interesting of the three, however, is "The Part Played by Aesthetic in the Development of Modern Philosophy." Kant left the problem of finding the relation between the sensuous and the supra-sensuous worlds. One of the chief factors in its solution has been reflection on esthetics. The philosophy of fine art permits us to see the idea embodied objectively in the sensuous realm. Bosanquet traces the influence of esthetic philosophy in Germany from Baumgarten to Hegel in widening and deepening the concrete grasp of life by research into the whole evolution of the human spirit, including the development of evolutionary science. (Thus the opposition between science and philosophy is reconciled.) The corresponding advance in England has been slower, and its agents for the most part have stood outside the ranks of the professional philosophers. As contributing to the modern viewpoint in philosophy, Bosanquet names Scott, Wordsworth, Shelley, Carlyle, Ruskin, Morris, Browning, Pater, Arnold, and George Eliot.

The broad scope of the volume above outlined suggests appreciative comment on Bosanquet's whole enterprise. Such comment, however, may well be omitted since there are readily accessible articles by competent scholars. I shall confine myself to two points, one of faith, one of doctrine. Bosanquet was ever urged forward in what he termed speculative philosophy by faith in the eternal unity of Reality. He believed that thought in all men and at all times reveals one and the same universe, and that we have enough "well-established facts" (p. 28) to test our philosophical proposi-

tions as to whether they are truly categorical or only partial in their scope. He believed in the steady advance of philosophical science, and he held "that the causal power which has created man is probably of such a nature as to give room for his development up to some marked grade of completeness, and for some sort of new tendency and appropriate change of ideal if and when the race is to come to an end" (pp. 129–130). All must respect the integrity of thought and life by which he exemplified his speculative ideal.

With due regard for the coherence of his system, however, I believe that at one point he carried his faith in unity into a dogmatic opinion which influenced his entire philosophy. He insisted on the adjectival character for Reality of finite individuals. He claimed that the spiritual individual is "a sub-variant of his age," and that the perfection of a finite individual would imply his identity with the Absolute (pp. 108–109). He concluded that creation implies underlying oneness with creator, and ultimate eternity of all spirits in God.

Did his philosophical system force him to this Spinozistic conclusion? I find in it aspects which make another view possible. He argued that negativity is a necessary element of the Absolute. "It is not an imperfection in the Supreme Being, but an essential of His completeness, that His nature, summing up that of all Reality, should go out into its other to seek the completion which in this case alone is absolutely found" (p. 86). On this view finite individuals might be regarded as finite portions of the Absolute. And yet Bosanquet argued in another passage (p. 109) that a finite individual, if substantive, must be capable of attaining perfection and must also be entirely self-dependent. On the contrary, a finite individual may be conceived, in the character of a partial system within Reality, as wholly dependent upon the Absolute, though possessing a substantive character made possible by the negative element in the whole. Its perfection, in such a case, would be relative to its nature, as one star differing from another star in glory. Finally, the objection that the finite individual in changing from youth to maturity fails to preserve his identity (p. 104, footnote) is based on what in another connection Bosanquet must call a false theory of identity which refuses to admit identity in difference.

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Marx and Lenin: the Science of Revolution. MAX EASTMAN. New York: Albert and Charles Boni. 1928. Pp. 263.

Whether Mr. Eastman intended to or not, he has succeeded in Americanizing Marxian Socialism. He not only proceeds to criti-

cize the Marxian philosophy from the standpoint of American thought, but he is indelicate enough to ask the purely American question: "What are we going to do about this business?" The second part of the book hints at what Mr. Eastman seems to consider a business-like answer. This part is called the "Science of Revolutionary Engineering," a title which might easily find a place in the announcements of our larger university extensions.

The standpatters, the reactionaries, indeed, the patriotic societies, ought to offer a vote of thanks to Mr. Eastman, for he has not only succeeded in Americanizing his subject-matter, but he has also produced an extremely good book at the same time. *Marx and Lenin* is a provocative, exciting, and completely entertaining volume.

Probably the greatest source of delight comes from the author's unrelenting determination to examine an important though clouded philosophy in terms of a much more definite set of ideas. Espousing philosophical pragmatism and using her (pragmatically enough) as his hand-maiden, he sets about exploring the traditional jungle of knotted and unrelated ideas which have crept up around the not-too-unified fruition of the Hegelian seeds planted by Marx's old tutors. Certain typical growths he notes; examines them with that cold dispassion which is characteristic of every American pragmatist at his task of being pragmatic.

The first part of the book takes up successively dialectic materialism—Marx's translation of Hegelianism the materialistic interpretation of history which grows out of this; the theory of class struggle, which embodies the social structures for a materialistic history; the Marxian ideology as construed by Marx and as criticized by pragmatism; and, finally, a wee bit of Marxian economics.

It is Mr. Eastman's contention that Marx, in spite of Feuerbach's materialistic influence upon him and in spite of his own determined efforts, never freed himself from the absolutism of the Hegelian school. The two influences made him a great social critic and allowed for the contribution which, to Eastman, Marx was to make. The second, however, rendered him impotent to accomplish his avowedly creative tasks. Marx's contribution was the materialistic methodology,—by which, Mr. Eastman believes, social scientists can evolve a revolutionary science. It is the methodology, for instance, by which the student can locate the ideological sources of institutions and the institutional sources of ideologies. Such an attitude should have made for Marx's defection from the absolutistic standards. Instead, the argument of the book goes, Marx as regards Marxism was adamant. This attitude was bequeathed to his followers. They in turn found Truth in this legacy and revelled in it, while a rapidly moving world exchanging institution for institution, ideology for

ideology, looked mildly shocked upon their opaqueness. This, says the author, accounts for the failure of traditional Marxism, a failure which will continue until the Marxian methodology is applied wholeheartedly, until the words of the Master's book will be taken no longer for Gospel, but as a passing, though important, phase, even as the entire *opera* had truly testified.

So when in the second part Mr. Eastman goes to lay the foundations for a new engineering structure, he makes sure to guard against the weaknesses of the older rotting hulk. There is still much of practical benefit in Marxism. So, and he proceeds to inspect most of them, with the other kinds of socialism. They all have made mistakes—which he jots down—which must be guarded against. Finally, and this is the only practical suggestion he makes beyond methodological ones, the work of Lenin contains in it the basis for a thorough-going and highly satisfactory, indeed practical, revolution, if handled with care and in terms of the materials presented.

Except as an evidence of massive reading in socialistic literature, the second part does not recommend itself with the vigor or *éclat* of the first. A good deal of the pleasure of reading this part, comes from noticing how his revolutionary enthusiasm led him into the same logical pitfalls in which he had earlier shown the Master sprawling. After informing the reader that the Hegelian epistemology was only possible and not actually true, and therefore could not give a true picture of life, he blithely postulates: "Life is impulsive, and thought is a definition of impulse and of the means to its satisfaction" (p. 79). Mr. Eastman, though well read in Dewey's writings, had overlooked a little essay called "The Reflex Arc Concept." Nor, indeed, is this sentence a mere literary gesture. Instead it embodies Mr. Eastman's repeatedly reiterated psychological thesis. It is the thesis which is brought in to give validity to his entire purpose. In this doctrine of shifting ideologies, conditioned as they are by hidden self-centered purposes and brought to light only in terms, as the author explains, of a kind of social Freudian rationalization, how can any one be sure he is taking the right step or even of thinking straight? Why has a socialist any better chance than a capitalist at getting the right practical answer? The situation calls for a psycho-analyst, not a revolutionary engineer. But Hegel's ghost rises up once more and gives transparent sustenance to a drooping brother spirit. There is a direction to it all. There is a millennium—a millennium of intelligences. Translated into philosophical terms, in spite of Mr. Eastman's heated disavowals, there is a synthesis. The last paragraph of the last page of part one reads:

"With Hegel it was a way out of these same presuppositions

into a world of metaphysical emotion. Abandon those intellectualistic presuppositions and . . . you find yourself *in* the world of practical action, for that is the real world in which the function of thinking actually developed" (p. 117).

Without stopping to exhibit the number of implicit postulates such a statement rests upon, let us become more practical. Let us ask "What are we going to do about it now that we are in the world of action?" Act—yes; but think? Why should we? Turn to the first sentence of the first paragraph of part one:

"It seems evident that conscious thought developed in the course of evolution only when it became needful as a means of survival."

Our problem is solved: our thinking about revolutionary engineering will develop (i.e., gain a validity even though it is only one more ideology) "when it becomes needful as a means of survival."

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JOURNALS AND NEW BOOKS

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NOTES AND NEWS

To the Editors of the Journal of Philosophy:

The articles of Sidney Hook on "The Philosophy of Dialectical Materialism" in your issues of March 1 and 15, 1928, have just come to my attention. In a foot-note on page 123, referring to some citations from Marx's early writings, Mr. Hook says:

"These citations are sufficient refutation of the cheap gibes Max Eastman pokes at Marx in his *Marx and Lenin; The Science of Revolution* (New York, 1927), for the alleged inconsistency between Marx's theoretical conception of history and his practical political activity. In the interests of a double-quick time revolution, Max Eastman has raked over all the old ashes of Marxian controversy to show that Marx was ruined by his metaphysical heritage and that Lenin as a 'scientific engineer' and 'professional' revolutionist becomes the new Messiah for advanced social thinkers."

May I have a small space in which to protest against a literary slander? The citations in question do not conflict with the thesis of my book, correctly stated, but Mr. Hook may sincerely think that they do, and that controversial question I will take up at length in another place. I wish here merely to protect against flagrant misrepresentation.

There is not a gibe of any kind against Marx in my book. There is not a word which could justify that irresponsible remark. Mr. Hook knows well enough that I call myself a Marxist, and that I called myself a Marxist at a time when it cost something more than academic prestige to do it. He knows also, for he has read my book, that the criticisms I do direct against Marx are not concerned with "an alleged inconsistency between Marx's theoretical conception of history and his practical political activity," but with the inconsistency between Marx's theoretical conceptions and modern views of the mind and of scientific method. He also knows that, far from trying to "show that Marx was ruined by his metaphysical heritage," I have proved to the best of my ability that, in spite of his metaphysical system, which is flimsy and false, Mark laid down all the fundamental principles of the science which Lenin applied.

Speaking of Marx's general achievement, I say (p. 67) that "Marx made almost exactly the same contribution to the science of history [that Darwin did to the science of biology]. He put in the place of moralistic and religious and poetic and patriotic eloquences a matter-of-fact principle of explanation which has become the dominating one for all freely inquiring minds, and he established—or at least first adequately emphasized—the fact that there has been an evolution, not only in the political forms of society, but in its

economic structure." And speaking of his particular contribution to socialist theory I say (p. 125): "A gigantic practical undertaking demands first an examination of the existing materials and forces, and the formation on the basis of this examination of a plan for achieving it. It is this examination and definition of facts with a view to achieving an otherwise utopian ideal, which constitutes the essential scientific work of Karl Marx. His plan can be shown to grow inevitably out of an adequate comprehension and bold facing of the facts." It is obvious that these statements do not come out of a book which pokes "cheap gibes" at Marx, or tries to "show that he was ruined by his metaphysical heritage."

I think that Mr. Hook must also know that I am not impatient of the speed of revolutionary processes—I am concerned with the problem of the possibility and the method of guiding them to fruitful ends. He certainly does know that I have not "raked over the old ashes of Marxian controversy." What I have done is to examine and expound the relations between orthodox Marxism and modern psychology and logic, with particular regard to the instrumental view of knowledge. This happens to be—as Mr. Hook has stated to me in a letter—a thing which he himself had planned to do. Inevitably I anticipated him in great measure.

Mr. Hook's criticism of the Marxian philosophy of history (pp. 150–151 of his articles in your Journal) is nothing but a paraphrase in more academic language of the corresponding passage (pp. 50, 51) of my book. Thoughts are not property, however, and I should not protest against his borrowing from me without the formality of recognition in a footnote. I protest against his putting flagrant misrepresentation in the place where such recognition is usually accorded.

MAX EASTMAN.

CRÔTON-ON-HUDSON.

George Martin Duncan, formerly for twenty years Professor of Logic and Metaphysics at Yale University, died at Hackensack, New Jersey, July 26. Professor Duncan retired in 1923 at the age of sixty-five years from Yale University with the title of Professor Emeritus, after spending thirty-five years on the staff of that University. He was the author of *The Philosophical Works of Leibnitz.*